

FIRST REPORT OF THE GENUS *SIPHLAENIGMA* PENNIKET AND THE
FAMILY SIPHLAENIGMATIDAE (EPHEMEROPTERA) FROM AUSTRALIA

C. R. LUGO-ORTIZ AND W. P. MCCAFFERTY

Department of Entomology, Purdue University, West Lafayette, IN 47907, U.S.A. (e-mail: carlos_lugo-ortiz@entm.purdue.edu).

Abstract.—*Siphlaenigma edmundsi*, new species, is described from larvae from New South Wales, Australia. The species is distinguished from *S. janae* by its relatively small size, elongate and subconical maxillary palp segment 3, apicomediaally broadly rounded labial palp segment 2 and subconical segment 3, poorly tracheated gills, and simple abdominal coloration. This is the first report of Siphlaenigmatidae outside of New Zealand. Based on the new distribution, *Siphlaenigma* may be at least 80 million years old and has evolved very little during that period.

Key Words: *Siphlaenigma*, Siphlaenigmatidae, Australia

Penniket (1962) proposed the mayfly family Siphlaenigmatidae for the New Zealand species *Siphlaenigma janae* Penniket. His basis for Siphlaenigmatidae was that, although larvae of *S. janae* were generally similar to those of Siphonuridae s.l. and Baetidae, its adults did not fit the concepts of either family. Edmunds et al. (1963), Demoulin (1968), and Edmunds (1972, 1973) agreed with Penniket's (1962) placement of *S. janae* in a separate family. Riek (1973), McCafferty and Edmunds (1979), and Landa and Soldán (1985), however, considered *S. janae* to represent a subfamily within Baetidae. Later, McCafferty (1991) assigned family status to *Siphlaenigma* Penniket following strict cladistic criteria.

Diagnosis of larvae of Siphlaenigmatidae remained somewhat problematic because no consistent characters had been found to distinguish it from all Baetidae. Recently, however, Wang and McCafferty (1996) discovered two diagnostic characters in the larval stage that clearly distinguish Baetidae from Siphlaenigmatidae and other families. In baetids, the initial lateral branches

of the epicranial suture are located anterior to (below) the lateral ocelli (Wang and McCafferty 1996: Figs. 1–6), and the femoral apices have a ventrally oriented dorsal lobe (Wang and McCafferty 1996: Figs. 13–16). In siphlaenigmatids, however, the initial lateral branches of the epicranial suture are near the posterior edge of the lateral ocelli (Wang and McCafferty 1996: Fig. 7), and the femoral apices lack the ventrally oriented lobe (Fig. 7). The adults of Siphlaenigmatidae differ from adults of Baetidae in having four-segmented mid- and hindtarsi (Penniket 1962: Figs. 7, 8), basally united IMA and MA₂ veins in the forewing (Penniket 1962: Fig. 1), hindwing with multiple longitudinal veins (Penniket 1962: Fig. 1), reduced but sclerotized penes (Penniket 1962: Fig. 3), and genital forceps with a long segment 1 and short, subequal segments 2 and 3 (Penniket 1962: Fig. 4). The absence of turbinate eyes in male adults of Siphlaenigmatidae also distinguishes it from almost all Baetidae; however, the South American baetid genus *Aturbina* Lugo-Ortiz and McCafferty was

found atypically to have lost the turbinate eyes (Lugo-Ortiz and McCafferty 1996: Fig. 12).

Since Penniket's (1962) work, *Siphlaenigmatidae* has been considered monotypic and endemic to New Zealand. While studying specimens from Australia recently donated to us by George F. Edmunds, we discovered that he collected *Siphlaenigma* larvae in New South Wales over 30 years ago. The material had been initially sorted out with Australian Baetidae and thus has remained unrecognized until now. This is an important discovery particularly in terms of biogeography because most other pisciform mayflies known from Australia show classical Amphinotic patterns with closely related genera in New Zealand, Australia, and Chile/Patagonia.

Baetids are very poorly known in Australia, with many species as well as genera having remained unstudied and undescribed. Much of the materials from Australia that we have seen are simply identified as Baetidae sp., as was, for example, the *Siphlaenigma* we report here. Given the fact that *Siphlaenigmatidae* larvae superficially resemble Baetidae (see discussion above) and that they also are behaviorally similar when seen and taken in the field (G. F. Edmunds, pers. comm.), it was not surprising to us when we found *Siphlaenigma* in Australian collections or that the taxon has been historically unrecognized by entomologists. This discovery is no more surprising, for example, than our recent discovery from Australia of the baetid genus *Cloeodes* Traver (Lugo-Ortiz and McCafferty 1998) and other baetid genera known from other parts of the world that have historically gone unrecognized in Australia. Finally, any doubt that the *Siphlaenigma* we report actually come from Australia, can be quelled by the facts that (1) the new species of *Siphlaenigma* is very distinct from the well-known New Zealand species, and (2) Edmunds (pers. comm.) filled out his locale labels in the field. We expect that re-examination of materials of

Australian "Baetidae" in other collections, in light of this report and new studies on Australian Baetidae, will lead to the discovery of additional specimens of *Siphlaenigma*.

The materials described and compared below are housed in the Purdue Entomological Research Collection, except where noted.

***Siphlaenigma edmundsi* Lugo-Ortiz and McCafferty, new species**
(Figs. 1–10)

Larva.—Body length: 5.9–6.2 mm; caudal filaments length: 2.1–2.5 mm. *Head*: Coloration pale yellow-brown, with no distinct pattern. Labrum (Fig. 1) with submedial pair of long, fine, simple setae and anterior submarginal row of two to three long, fine, simple setae. Hypopharynx as in Fig. 2. Left mandible (Fig. 3) with outer set of incisors with four denticles, inner set with three denticles; prostheca medially with long, fine, simple setae. Right mandible (Fig. 4) with outer set of incisors with four denticles, inner set with three denticles; prostheca medially with long, fine, simple setae. Maxilla (Fig. 5) with single row of six to eight relatively long, fine, simple setae near medial hump; palp extending beyond galealacinia; palps three segmented; palp segment 1 approximately 0.80× length of segments 2 and 3 combined; segment 3 relatively long and subconical. Labium (Fig. 6) with glossa subequal in length to paraglossa; glossa bare; paraglossa with abundant short, fine, simple setae laterally and medially; palp three segmented; palp segment 1 as long as segments 2 and 3 combined, with scattered relatively robust, apically pointed, simple setae laterally; palp segment 2 with abundant long, fine, simple setae laterally and medially, and long, relatively robust, apically pointed simple setae distomedially; palp segment 3 subconical and relatively long. *Thorax*: Coloration pale yellow-brown, with no distinct pattern. Legs (Fig. 7) pale yellow-brown; femora with row of relatively short, fine, apically

pointed, simple setae dorsally and ventrally, and short, fine, apically pointed, simple setae scattered over surface; tibiae with row of relatively short, fine, apically pointed, simple setae dorsally and ventrally, and short, fine, apically pointed, simple setae scattered over surface; tarsi with row of relatively short, fine, apically pointed, simple setae dorsally and ventrally, and short, fine, apically pointed, simple setae scattered over surface; tarsal claws (Fig. 8) with two rows of 14–16 minute, apically pointed, slender denticles. *Abdomen*: Coloration pale yellow-brown, with no distinct pattern; terga 1 and 10 uniformly pale yellow-brown; terga 2–9 uniformly pale yellow-brown, with submedial anterior medium brown subtriangular markings. Tergal surfaces (Fig. 9) creased. Sterna pale yellow-brown. Gills 1–7 (Fig. 10) narrow, poorly tracheated, approximately $1.25\times$ length of corresponding segments. Paraprocts without marginal spines. Caudal filaments pale yellow-brown to cream, with relatively broad medium brown band near middle.

Adult.—Unknown.

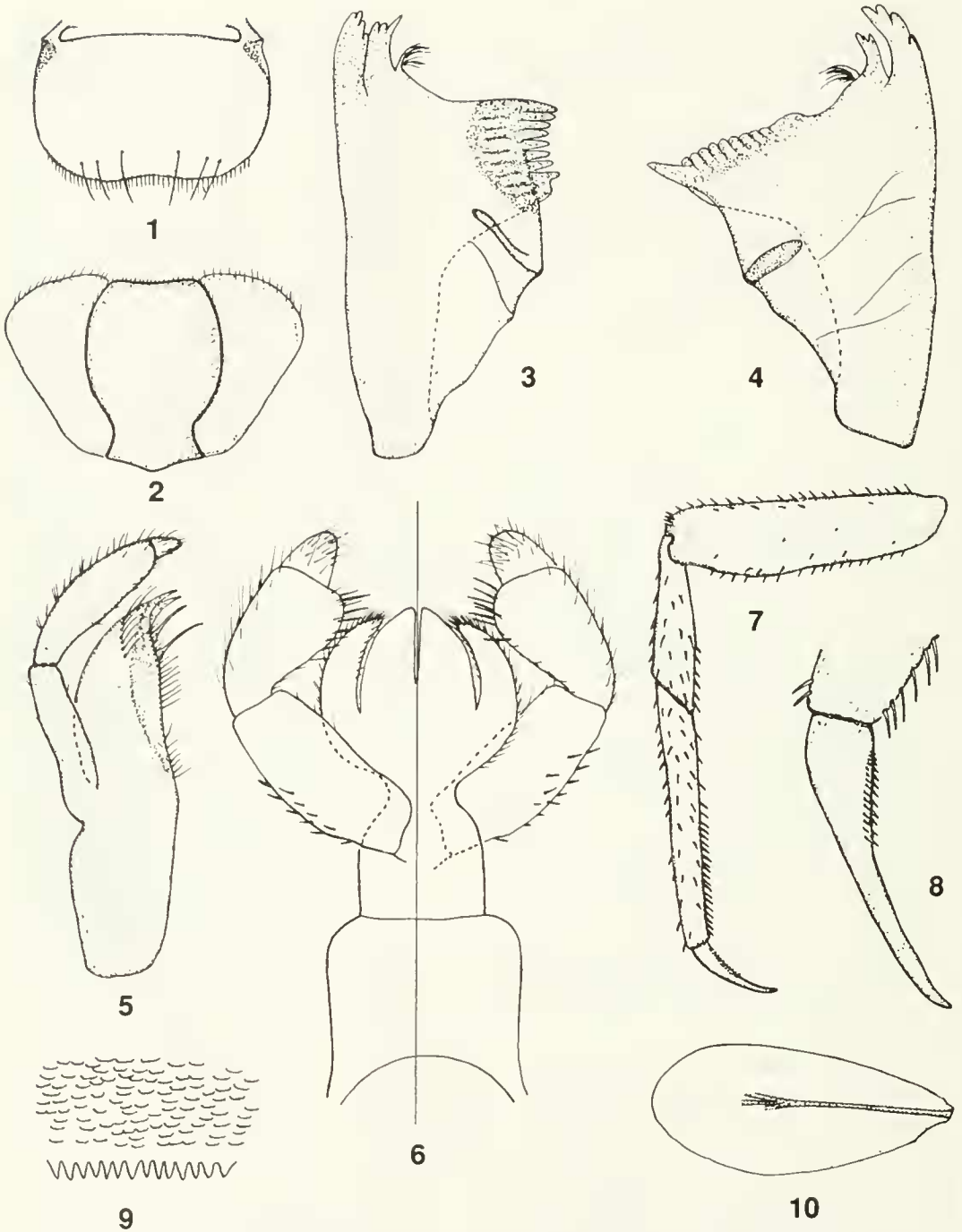
Material examined.—Holotype: Larva, AUSTRALIA, New South Wales Prov., tributary of Mongarlowe R., nr. Monga, Clyde Mtn., 1-25-1966, G. F. Edmunds, Jr. Paratypes: Five larvae, same data as holotype [mouthparts, forelegs, tergum 4, gill 4, and paraproct of one larva mounted on slide (medium: Euparal)] (one larva deposited in the Australian National Collection, Canberra). Additional material: 19 larvae, same data as holotype.

Etymology.—We are honored in naming this species after the collector, George F. Edmunds, Jr.

Discussion.—*Siphlaenigma edmundsi* differs from *S. janae* in its smaller size and in having segment 3 of the maxillary palps relatively elongate and subconical (Fig. 5), labial palps with an apicomediaally broadly rounded segment 2 and a subconical segment 3 (Fig. 6), poorly tracheated gills (Fig. 10), and abdominal terga with a simple color pattern. Although the two species are

distinctive, they are fundamentally similar and do not warrant distinction as separate genera. The fact that the two species are congeneric is significant because no other mayfly genus is known to occur in Australia and New Zealand. [The leptophlebiid genus *Atalophlebioides* Phillips has been reported from Australia and New Zealand, but Hubbard and Campbell (1996) have indicated that Australian species currently assigned to it most probably represent a different taxon.]

The discovery of *Siphlaenigma* in Australia strongly suggests that the taxon was present in Transantarctica prior to the separation of New Zealand approximately 80 million years ago. As a consequence, any notion that Siphlaenigmatidae evolved in New Zealand after the two landmasses were isolated is now insupportable, and new perspectives with respect to the historical biogeography of the family can now be taken. For example, it is possible that Siphlaenigmatidae was relatively widespread in western Gondwana during most of the Cretaceous and that it was decimated during the massive extinctions completed by the end of that period approximately 65 million years ago (McCafferty 1990, 1991, Wilson 1992). The two species of Siphlaenigmatidae that are known today, as such, would represent phylogenetic relicts. This would be consistent with the phylogenetic and paleontological observations by McCafferty (1990, 1991) and McCafferty and Wang (1997) showing that mayfly lineages in the Southern Hemisphere suffered major extinctions by the end of the Cretaceous. McCafferty and Wang (1997) showed that Southern Hemisphere phylogenetic relicts, viz., Ameletopsidae, Coloburiscidae, Oniscigastridae, Nesamelitidae, Rallidentidae, and Teloganodidae, have small genera with one or few species each. The same may be said for clades within the Atalophlebiinae (Leptophlebiidae) (Towns and Peters 1978, 1996). Furthermore, Siphlaenigmatidae eventually may be found in southern temperate South America. Such Transantarctic



Figs. 1-10. *Siphlaenigma edmundsi*. 1, Labrum (dorsal). 2, Hypopharynx. 3, Left mandible. 4, Right mandible. 5, Right maxilla. 6, Labium (left-ventral; right-dorsal). 7, Right foreleg. 8, Tarsal claw. 9, Detail of tergum 4. 10, Gill 4.

affinities have been shown for several groups of aquatic insects, including Plecoptera (Illies 1965), Chironomidae (Brundin 1966), Trichoptera (Ross 1967), and Ephemeroptera (Edmunds 1975). Unlike other Amphinotic groups of mayflies, however, the same genus of Siphlaenigmatidae is found in different major isolated areas. This indicates that Siphlaenigmatidae, at least in terms of the larval stage, has evolved very little during the past 80 million years.

ACKNOWLEDGMENT

This paper has been assigned Purdue Agricultural Research Program Journal No. 15420.

LITERATURE CITED

- Brundin, L. Z. 1966. Transantarctic relationships and their significance as evidenced by chironomid midges. *Kungliga Svenska Vetenskapsakademien Handlingar* 11: 1-472.
- Demoulin, G. 1968. Sur l'origine et les tendances évolutives des Baetidae et des Siphlaenigmatidae (Ephemeroptera). *Bulletin Institut Royal des Sciences Naturelles de Belgique* 45 (18): 1-8.
- Edmunds, G. F., Jr. 1972. Biogeography and evolution of Ephemeroptera. *Annual Review of Entomology* 17: 21-42.
- . 1973. Some critical problems of family relationships in the Ephemeroptera, pp. 145-154. *In* Peters, W. L. and J. G. Peters, eds., *Proceedings of the First International Conference on Ephemeroptera*. Brill, Leiden.
- . 1975. Phylogenetic biogeography of mayflies. *Annals of the Missouri Botanical Garden* 62: 251-263.
- Edmunds, G. F., Jr., R. K. Allen, and W. L. Peters. 1963. An annotated key to the nymphs of the families and subfamilies of mayflies (Ephemeroptera). *University of Utah Biological Series* 13: 1-49.
- Hubbard, M. D. and I. C. Campbell. 1996. *Catalogue of the Australian mayflies, recent and fossil* (Insecta: Ephemeroptera). Australian Society for Limnology Special Publication No. 11. 43 pp.
- Illies, J. 1965. Phylogeny and zoogeography of the Plecoptera. *Annual Review of Entomology* 10: 117-140.
- Landa, V. and T. Soldán. 1985. Phylogeny and higher classification of the order Ephemeroptera: A discussion from the comparative anatomical point of view. *Academia, Prague*. 122 pp.
- Lugo-Ortiz, C. R. and W. P. McCafferty. 1996. *Aturbina georgei* gen. et sp. n.: A small minnow mayfly (Ephemeroptera: Baetidae) without turbinate eyes. *Aquatic Insects* 18: 175-183.
- . 1998. First report and new species of the genus *Cloecodes* (Ephemeroptera: Baetidae) from Australia. *Entomological News* 109: 122-128.
- McCafferty, W. P. 1990. Chapter 2: Ephemeroptera, pp. 20-50. *In* Grimaldi, D., ed., *Insects from the Santana Formation, Lower Cretaceous, of Brazil*. *Bulletin of the American Museum of Natural History* 195. 191 pp.
- . 1991. Toward a phylogenetic classification of the Ephemeroptera (Insecta): A commentary on systematics. *Annals of the Entomological Society of America* 84: 343-360.
- McCafferty, W. P. and G. F. Edmunds, Jr. 1979. The higher classification of the Ephemeroptera and its evolutionary basis. *Annals of the Entomological Society of America* 72: 5-12.
- McCafferty, W. P. and T.-Q. Wang. 1997. Phylogenetic systematics of the family Teloganodidae. *Annals of the Cape Provincial Museums (Natural History)* 19: 387-437.
- Penniket, J. G. 1962. Notes on New Zealand Ephemeroptera. III. A new family, genus and species. *Records of the Canterbury Museum* 7: 389-398.
- Riek, E. F. 1973. Classification of the Ephemeroptera, pp. 160-178. *In* Peters, W. L. and J. G. Peters, eds., *Proceedings of the First International Conference on Ephemeroptera*. Brill, Leiden.
- Ross, H. H. 1967. The evolution and past dispersal of the Trichoptera. *Annual Review of Entomology* 12: 169-206.
- Towns, D. R. and W. L. Peters. 1978. A revision of the genus *Atalophlebioides* (Ephemeroptera: Leptophlebiidae). *New Zealand Journal of Zoology* 5: 607-614.
- . 1996. *Leptophlebiidae* (Insecta: Ephemeroptera). *Fauna of New Zealand* No. 36. Mnaaki Whenua Press, Canterbury, New Zealand. 143 pp.
- Wang, T.-Q. and W. P. McCafferty. 1996. New diagnostic characters for the mayfly family Baetidae (Ephemeroptera). *Entomological News* 107: 207-212.
- Wilson, E. O. 1992. *The Diversity of Life*. Belknap-Harvard Press, Cambridge, Massachusetts. 424 pp.